ANNUAL REPORT 1964

DUNNVILLE (REGIONAL) water treatment plant

DIVISION OF PLANT OPERATIONS

Ontario Water Resources Commission

ONTARIO WATER RESOURCES COMMISSION

OFFICE OF THE GENERAL MANAGER

Members of the Dunnville Local Advisory Committee.

Gentlemen:

We are pleased to provide you with the 1964 Operating Report for the Dunnville Regional Water Treatment Plant, OWRC Project No. 58-W-17.

By continuing the mutual cooperation which has existed in the past, we can look forward to greater progress in the field of water supply.

Yours very truly,

D. S. Caverly,
General Manager

General Manager,
Ontario Water Resources Commission.

Dear Sir:

It is with pleasure that I present to you the Annual Report of the operation of the Dunnville Regional Water Treatment Plant, OWRC Project No. 58-W-17 for 1964.

This report presents design data, outlines operating problems encountered and summarizes in tables, charts and graphs all significant flow and cost data.

Yours very truly,

B. C. Palmer, P. Eng.,
Director,
Division of Plant Operations.

FOREWORD

This report describes the operation of this project for the year 1964. It includes a detailed description of the project, summary of operation, graphs and charts showing quality and quantity information, and project cost data.

This information will be of value to the municipality in assessing the adequacy of the works in meeting existing requirements and in projecting its capability to meet future expected demands. The cost information will be of particular interest to those concerned with developing and maintaining revenue structures.

The preparation of this report has been a cooperative effort of several groups within the Division of Plant Operations. These include the Statistical Section, Brochures Officer and the Regional Supervisor. However, the primary responsibility for the content has been with the Regional Operations Engineer. He will be pleased to discuss all aspects of this report with the municipality.

B. C. Palmer, P. Eng.,
Director,
Division of Plant Operations.

CONTENTS

DUNNVILLE REGIONAL
water treatment plant

operated for

THE TOWN OF DUNNVILLE

SHERBROOKE METALLURGICAL COMPANY LIMITED

THE ELECTRIC REDUCTION COMPANY LIMITED

by the

ONTARIO WATER RESOURCES COMMISSION

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801 Bay Street **Toronto 5**

'64 REVIEW

This report provides information pertaining to the operation of the Dunnville Regional Water Supply System during the past year, paying particular attention to flows, treatment and costs.

The average daily flow of 10.163 million gallons in 1964 was a slight decrease from the 1963 average daily flow. This decrease was due primarily to the fact that the Town of Dunnville received water from the plant for only 11 days during September while the transmission line to Dunnville was relocated on the recently constructed bridges over the Grand River. All the microstrainers were equipped with Mark 1 fabric which replaced the original Mark O fabric. This change increased the capacity of these units and permitted longer operational periods between cleanings.

Supervision and technical assistance by head office engineers and technicians together with the excellent work of the plant staff, resulted in a well operated and maintained plant throughout the year. The operating cost during 1964 increased slightly to 2.66¢ per 1000 gallons. The total cost of supplying water was 8.40¢ per 1000 gallons.

During 1965 a concerted effort is to be made to find a solution to the frazil ice problem which periodically interrupts the water supply during the winter.

GLOSSARY

BTU	British Thermal Unit
flocculation	bringing very small particles together to form a larger mass (the floc) before settling
fps	feet per second
gpm	gallons per minute
lin. ft.	linear feet
mgd	million gallons per day
pH	a symbol for hydrogen-ion concentration; a pH test determines the intensity of the acidity or alkalinity of a water
ppm	parts per million
ss	suspended solids
SWD	side wall depth
TDH	total dynamic head (usually refers to pressure on a pump when it is in operation)
turbidity	a measurement of the amount of visible material in suspension in water

HISTORY
1957 - 1964

INCEPTION

In 1957, the Town of Dunnville and the Ontario Water Resources Commission initiated plans for the construction of a modern water treatment plant.

In 1958, two industries, the Sherbrooke Metallurgical Company Limited and the Electric Reduction Company Limited, began expanding in the Port Maitland area. Both of these industries required large amounts of water for their manufacturing process.

The Commission coordinated the needs of the town and industries and the firm of Canadian British Engineering Consultants, Toronto, were enlisted to design the necessary facilities.

CONSTRUCTION

Schwenger Construction Limited, Hamilton, began construction in October 1959 and by August 1960 the Division of Plant Operations took over partial operation of the plant. Complete operation of the project was achieved in November 1960.

TOTAL COST

$2,567,923.33 as of December 31, 1964

REG NEFF
SUPERINTENDENT

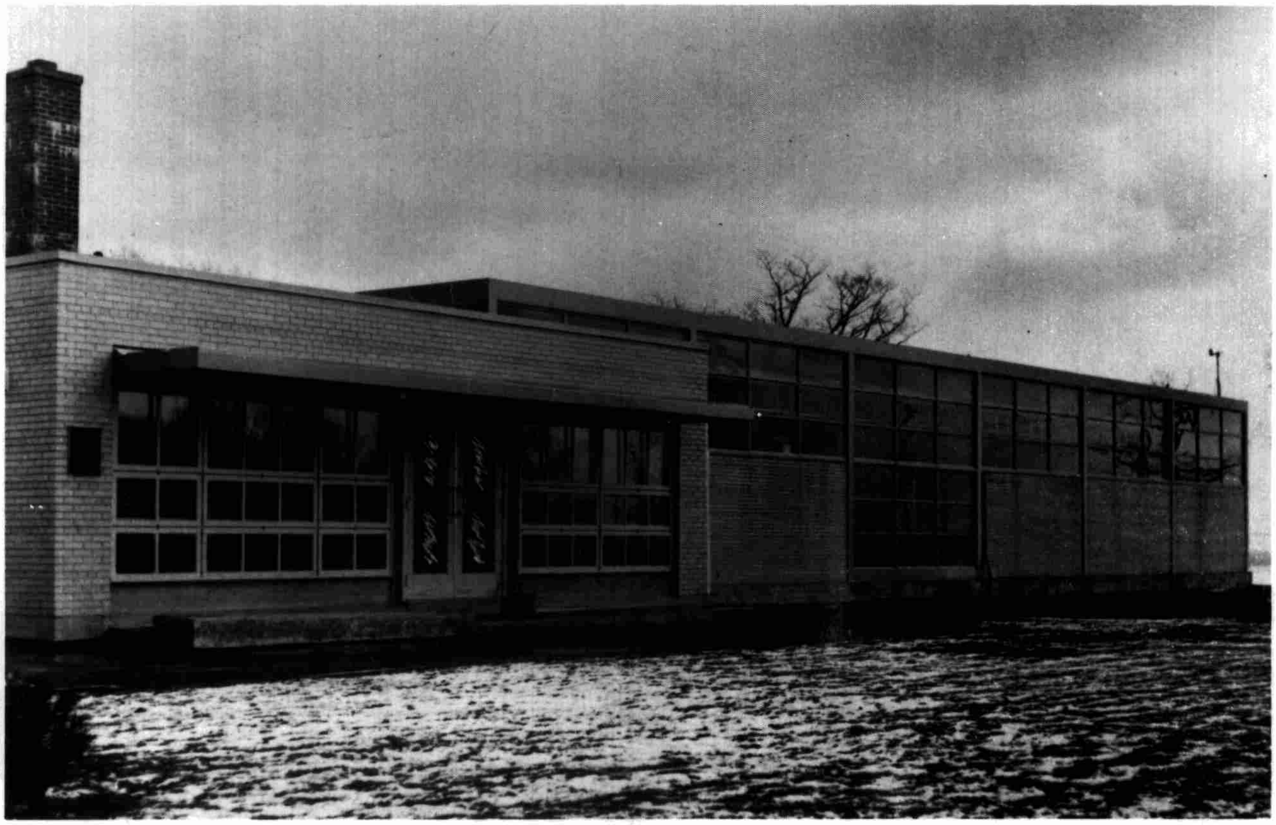
Project Staff

Assistant Superintendent:	Ross Root
Operators:	O. McLaughlin A. Clark J. Cown A. Miller R. Martineau

COMMENTS

During 1964, casual labour was used extensively to supplement the plant staff due to the heavy workload at the project. The microstrainer fabric conversion, painting and grounds maintenance required the assistance of the additional work force.

Mr. A. Clark attended the Intermediate Water Works Course held in Toronto and obtained a satisfactory standing. Mr. R. Neff, Plant Superintendent, attended the 1964 Chief Operators' Conference sponsored by the Commission.



Description of Project

INTAKE

The intake crib is located 1,300 feet out in Lake Erie in 25 feet of water. The raw water flows by gravity through the intake pipe which is laid in a rock cut on the lake bottom and is supported on sand bags filled with a mixture of sand and cement. The intake pipe terminates in the low lift pumping station pump wells.

LOW LIFT STATION

Just prior to entry to the pump wells, the raw water is screened by twin screens which may be removed one at a time for cleaning. The purpose of the screens is to remove any debris which would damage the low lift pumps.

The raw water is pumped to the microstrainers by three vertical turbine deep well pumps. These pumps are controlled by electrodes located in the clear well of the high lift station. At peak demand periods, all three pumps can operate in parallel.

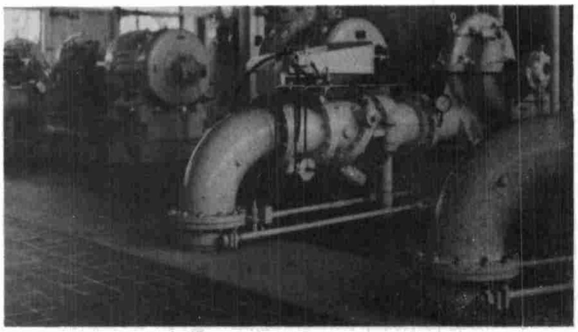
MICROSTRAINERS

Upon reaching the high lift station, the raw water passes through the microstrainers. A microstrainer consists of a revolving drum the circumference of which is covered with an extremely fine woven stainless steel cloth. The microstrainers remove most of the algae and other foreign material from the raw water as it passes through the fabric from the inside of the drum to the outside. The strained water then overflows from the microstrainer compartment into an effluent channel which flows into

one of two clear wells. The micro-strainer fabric is continually flushed by treated water from a wash water pump which has an intake in the microstrainer effluent channel.

CHLORINATION

Effluent from the microstrainers is stored in two clear wells located directly beneath the high lift pumping station. It is here that chlorine is added for disinfection. The chlorine is fed through proportional feed chlorinators the amount being determined by the rate of flow of raw water from the low lift station. Enough chlorine is added to maintain a slight residual in the water when it reaches the consumer's outlets. The chlorine equipment is installed in an isolated room in the high lift pumping station with the chlorine being stored in one ton cylinders in an adjacent roofed area. The cylinders are usually delivered to the plant in groups of seven and are moved as required from the storage area to the chlorinator room using a chain hoist sliding on a crane rail.

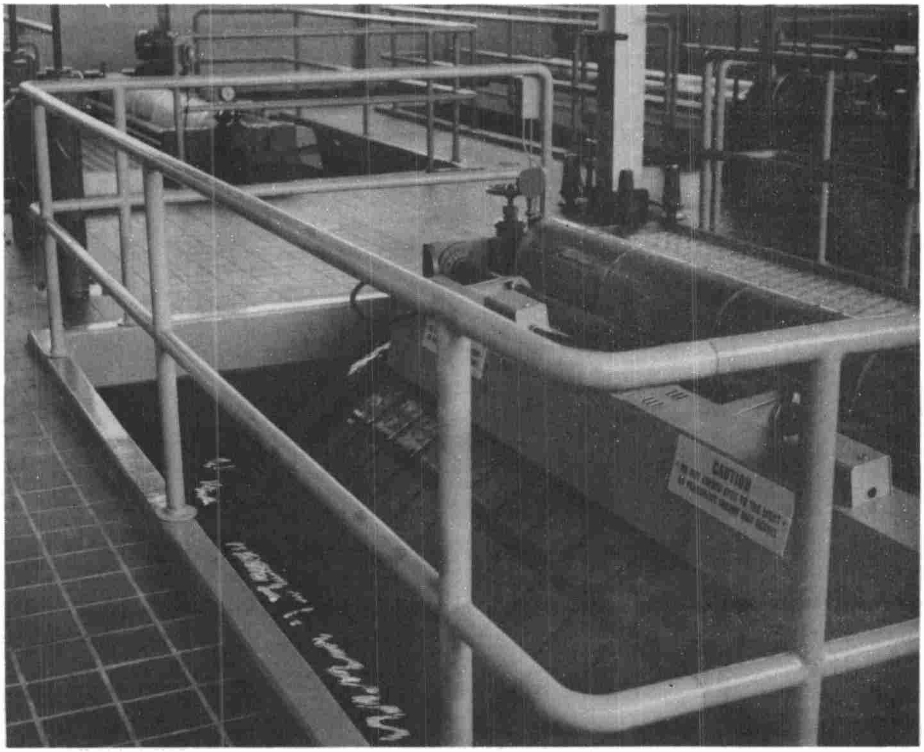


HIGH LIFT PUMPS

DISTRIBUTION

Treated water is drawn from the clear wells and distributed to Dunnville and Port Maitland using seven high lift pumps. The pumps are controlled by flow. As the flow increases, more pumps are brought into service.

A 36 in. diameter transite main serves the Port Maitland industrial complex and a 16 inch diameter transite main supplies the Town of Dunnville with its requirements.



MICROSTRAINER

ROOM

PROJECT COSTS

LONG TERM DEBT
(Total Capital Cost)

Dunnville	$ 546,753.63
Electric Reduction Co.	1,109,650.98
Sherbrooke Metallurgical Co.	911,518.72
TOTAL	$2,567,923.33

The total cost to the municipality during 1964 was as follows:

NET OPERATING		
Dunnville	$18,451.67	
Electric	44,276.07	
Sherbrooke	36,368.22	
		$ 99,095.96
DEBT RETIREMENT		
Dunnville	$11,033.49	
Electric	22,392.76	
Sherbrooke	18,394.44	
		$ 51,820.69
RESERVE		
Dunnville	$ 3,602.01	
Electric	7,520.57	
Sherbrooke	6,394.44	
		$ 17,300.32
INTEREST CHARGED		
Dunnville	$30,752.63	
Electric	62,415.28	
Sherbrooke	51,278.47	
		$ 144,446.38
		$ 312,663.35

RESERVE ACCOUNT

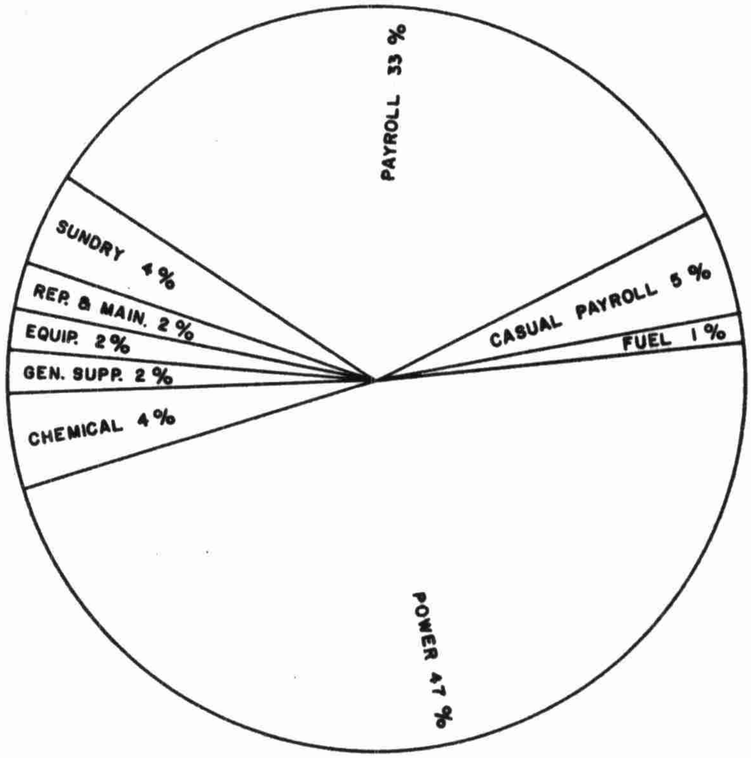
Balance at January 1, 1964		
Dunnville	$11,714.74	
Electric	24,630.72	
Sherbrooke	20,233.22	
		$ 56,578.68
Deposited by Participants		$ 17,135.64
Interest Earned		
Dunnville	$ 721,30	
Electric	1,512.41	
Sherbrooke	1,246.03	
		$ 3,479.74
		$ 77,194.06
Less Expenditures		
Dunnville	$ 753.10	
Electric	1,806.64	
Sherbrooke	1,489.20	
		$ 4,048.94
Balance at December 31, 1964		
Dunnville	$15,262.74	
Electric	31,729.66	
Sherbrooke	26,152.72	
		$ 73,145.12
DEBT OUSTANDING:		
Dunnville	$489,808.92	
Electric	1,010,594.64	
Sherbrooke	829,868.54	
		$2,339,272.10

MONTHLY COSTS

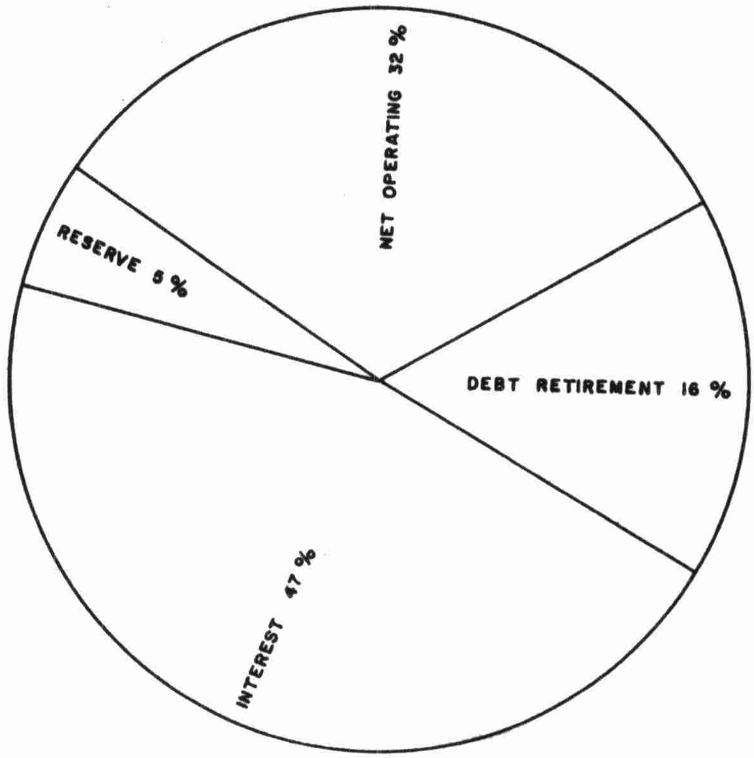
MONTH	TOTAL EXPENDITURE	PAYROLL	CASUAL PAYROLL	FUEL	POWER	CHEMICAL	GENERAL SUPPLIES	EQUIPMENT	REPAIRS & MAINTENANCE	SUNDRY	WATER
JAN	6662.43	2585.05		227.04	3586.52		51.41		125.81	111.75	(25.15)
FEB	6597.72	2471.66		209.08	3436.15	(76.16)	84.75	65.01	286.78	120.45	
MARCH	7350.83	2471.66		169.85	3413.49	270.00	28.84	49.81	35.31	911.87	
APRIL	6526.20	2483.78		171.94	3561.69	3.24	107.70	32.12	62.23	118.65	(15.15)
MAY	10,905.74	3717.19	724.98	93.14	3644.38	2325.49	58.53		44.38	297.65	
JUNE	10,433.67	2898.35	734.06	88.61	3809.33		196.71	236.77	101.03	2368.81	
JULY	7533.08	2550.86	842.04	8.09	3565.19	(67.50)	151.91	367.94		142.40	(27.85)
AUG	7675.16	2572.08	682.06		3822.43		190.55	122.57	172.62	114.85	(2.00)
SEPT	8411.40	2362.38	617.80		3521.55	1360.00	36.48	193.40	88.89	230.90	
OCT	9885.24	2798.17	628.76	13.35	3597.55	20.39	275.51	520.29	62.67	2049.65	(81.10)
NOV	7338.51	2267.28	226.37	51.47	3816.90	180.00	244.04		440.43	112.02	
DEC	9775.98	3902.67		180.20	6994.81	2.50	509.57	179.47	516.26	(2509.50)	
TOTAL	$99,095.96	33,081.13	4,456.07	1212.77	46,769.99	4,017.96	1,936.00	1,767.38	1,936.41	4,069.50	(151.25)

BRACKETS INDICATE CREDIT

1964 OPERATING COSTS



TOTAL ANNUAL COST



SUMMARY OF WATER COSTS

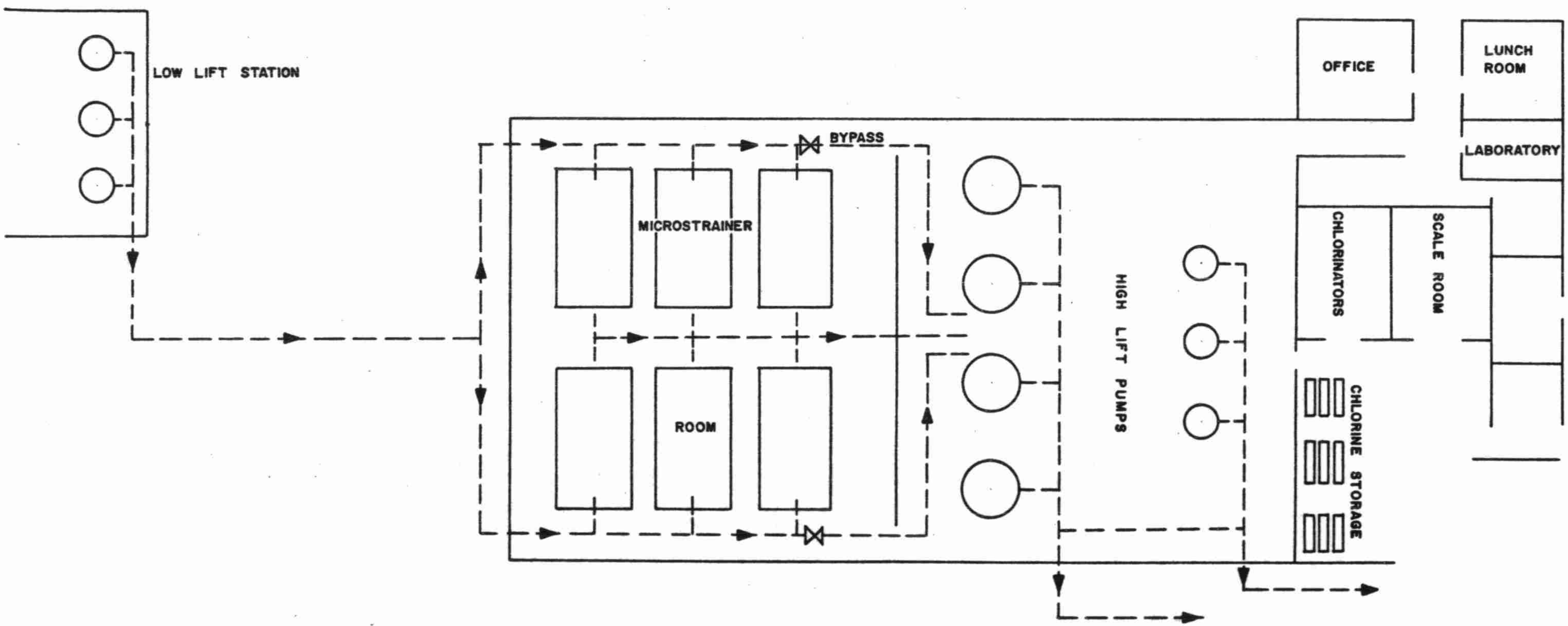
Year	M. G. Treated	Operating Cost	Operating Cost per 1,000 gallons	Total Cost	Total Cost per 1,000 gals.
1961	2245.838	$71,428.00	3.18¢	$276,047.37	12.29¢
1962	3214.853	85,564.88	2.66¢	297,494.48	9.25¢
1963	3726.935	95,458.82	2.56¢	309,179.48	8.29¢
1964	3719.568	99,095.96	2.66¢	312.663.35	8.40¢

COST TO EACH PARTICIPANT IN 1964

Participant	M. G. Used	Operating Cost	Operating Cost per 1,000 gallons	Total Cost	Total Cost per 1,000 gals.
Town of Dunnville	310.612	$18,451.67	5.94¢	$63,839.80	20.50¢
Electric Reduction	1231.601	44,276.07	3.61¢	136,604.68	11.10¢
Sherbrooke Metalurgical	2177.355	36,368.22	1.67¢	112,218.87	5.15¢

Technical Section

DUNNVILLE WATER TREATMENT PLANT



Design–Data

DESIGN CAPACITY OF PLANT

20.5 MGD.

INTAKE

48" asbestos bonded corrugated metal.

SCREENING FACILITIES

Four removeable screens 5'6" square having 3/8" openings.

Each screen can be removed for cleaning by individual rocket hoists by David Round & Son.

LOW LIFT PUMPS

Three Byron Jackson vertical turbine pumps. Each pump is rated at 5700 GPM @ 38 ft. TDH.

Three Westinghouse encapsulated line start induction motors. Each motor is rated at 75 HP.

MICROSTRAINERS

Six 10 ft. long x 10 ft. diameter machines as manufactured by Glenfield & Kennedy. All machines are equipped with Mark I fabric having a maximum opening of 35 microns.

WASH WATER PUMPS

Two Babcock-Wilcox & Goldie McCulloch centrifugal pumps rated at 500 GPM @ 100 ft. TDH.

Two Westinghouse encapsulated life-line motors rated at 20 HP.

CLEAR WELLS

Two compartments having a total capacity of 200,000 Imperial gallons. Detention time at 20.5 MGD = 18.25 minutes.

HIGH LIFT PUMPS

One Wheeler Economy Pump - 1200 GPM @ 135 ft. TDH driven by a 50 HP English electric motor.

Two Wheeler Economy Pumps - 1440 GPM @ 230 ft. TDH.

Four horizontal drive Worthington pumps. These pumps are rated such that when any three are operating in parallel, they will produce 4,000 GPM each at 220 ft. discharge pressure.

Three pumps are driven by 350 HP Associated Electrical Industries constant speed motors. The fourth pump is driven by a 350 HP synchronous motor by English electric connected through a Dynamatic Eddy Current Coupling.

CHLORINATION

Two Wallace & Tiernan Series A-711 variable vacuum control chlorinators capable of metering 2,000 lbs. of chlorine per day.

Storage facilities are provided for 15 one ton cylinders.

DISTRIBUTION SYSTEM

TO TOWN OF DUNNVILLE

23,000 feet of 16" diameter asbestos cement pipe which supplies a maximum of 2,400 GPM to either the filtration plant or directly to the town distribution system.

TO PORT MAITLAND

20,000 feet of 36" diameter asbestos cement pipe pumped directly to the industrial distribution system in Port Maitland.

Process Data

GENERAL

The treatment of water at the Dunnville plant consists of microstraining to remove such things as algae and gross solids, and disinfection by the addition of chlorine. The following data provides information regarding the output of the plant, the quality of the raw water, the quality of the treated water and chlorine dosages necessary to maintain safe water. The quality of the water is discussed using such terms as filterability and turbidity. An effort is made to define the meaning of these terms and graphs have been drawn to indicate the frequency of occurrence of various readings.

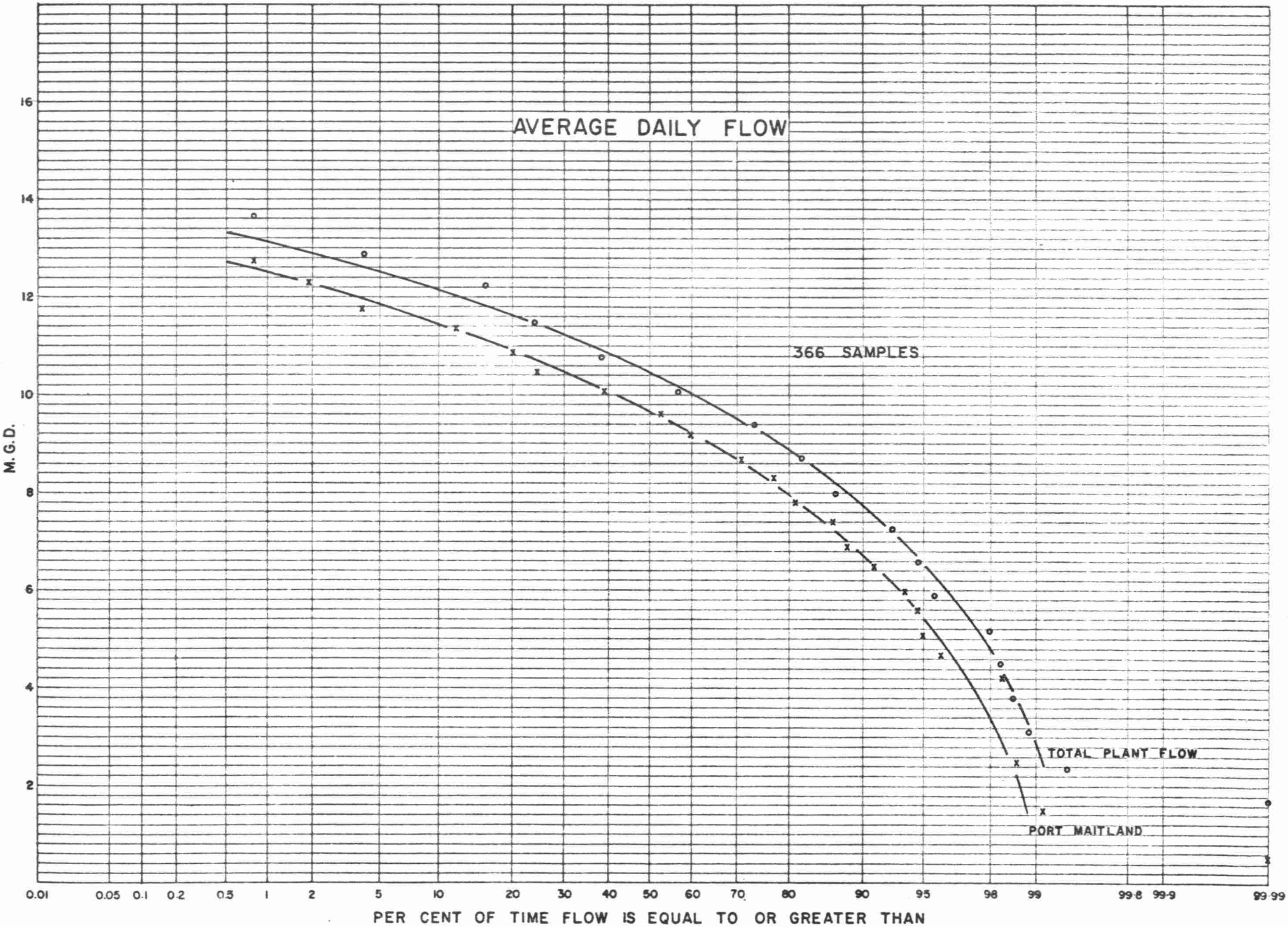
FLOW

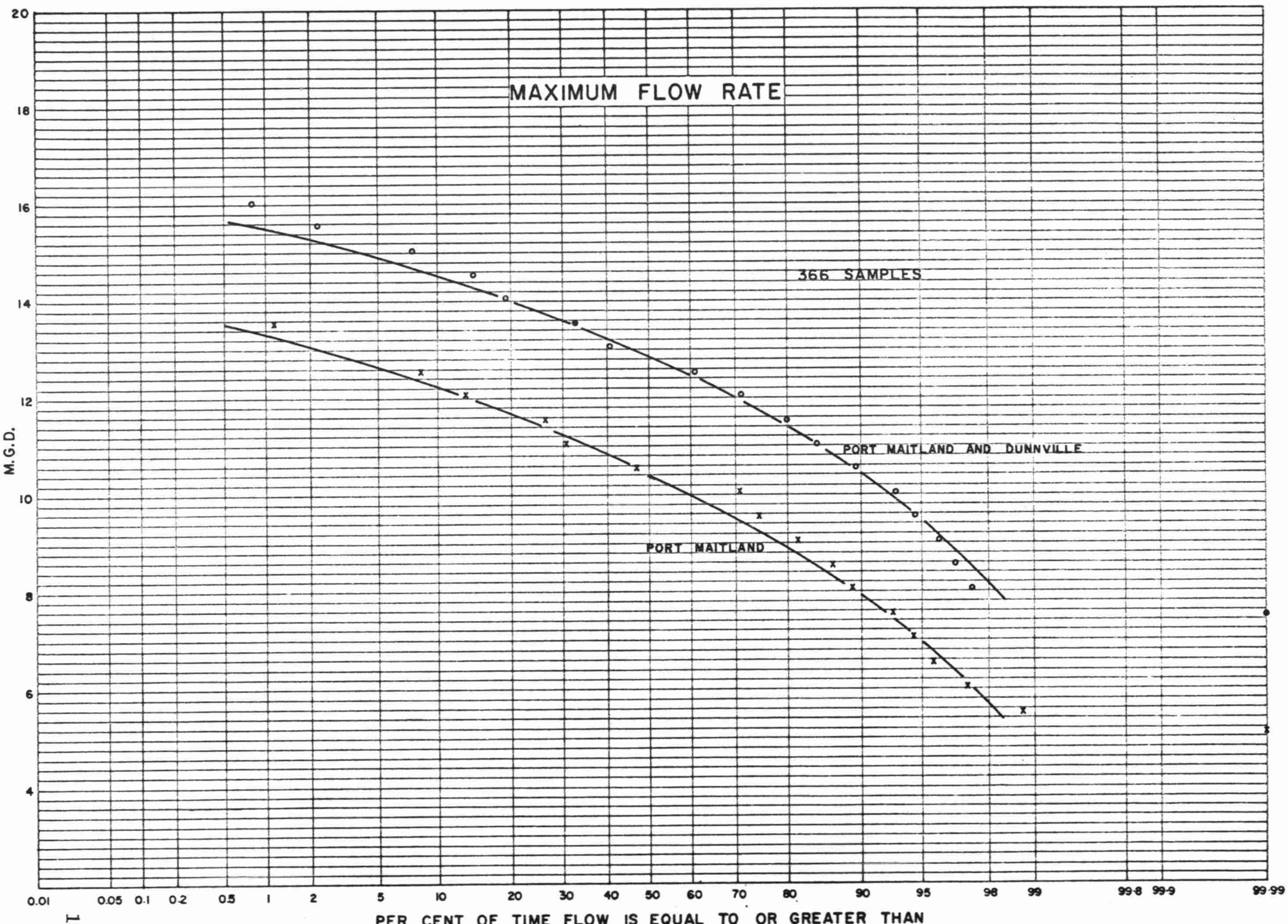
During 1964 a total of *3719. 568 million gallons of water were pumped from the Dunnville Regional Water Treatment Plant. The decrease in water pumped of approximately 0. 2% from 1963 was due primarily to the Town of Dunnville accepting water from the plant for only 11 days in September. A shutdown of the Dunnville transmission line in order to relocate the line on the new bridges over the Grand River was the cause of the interruption.

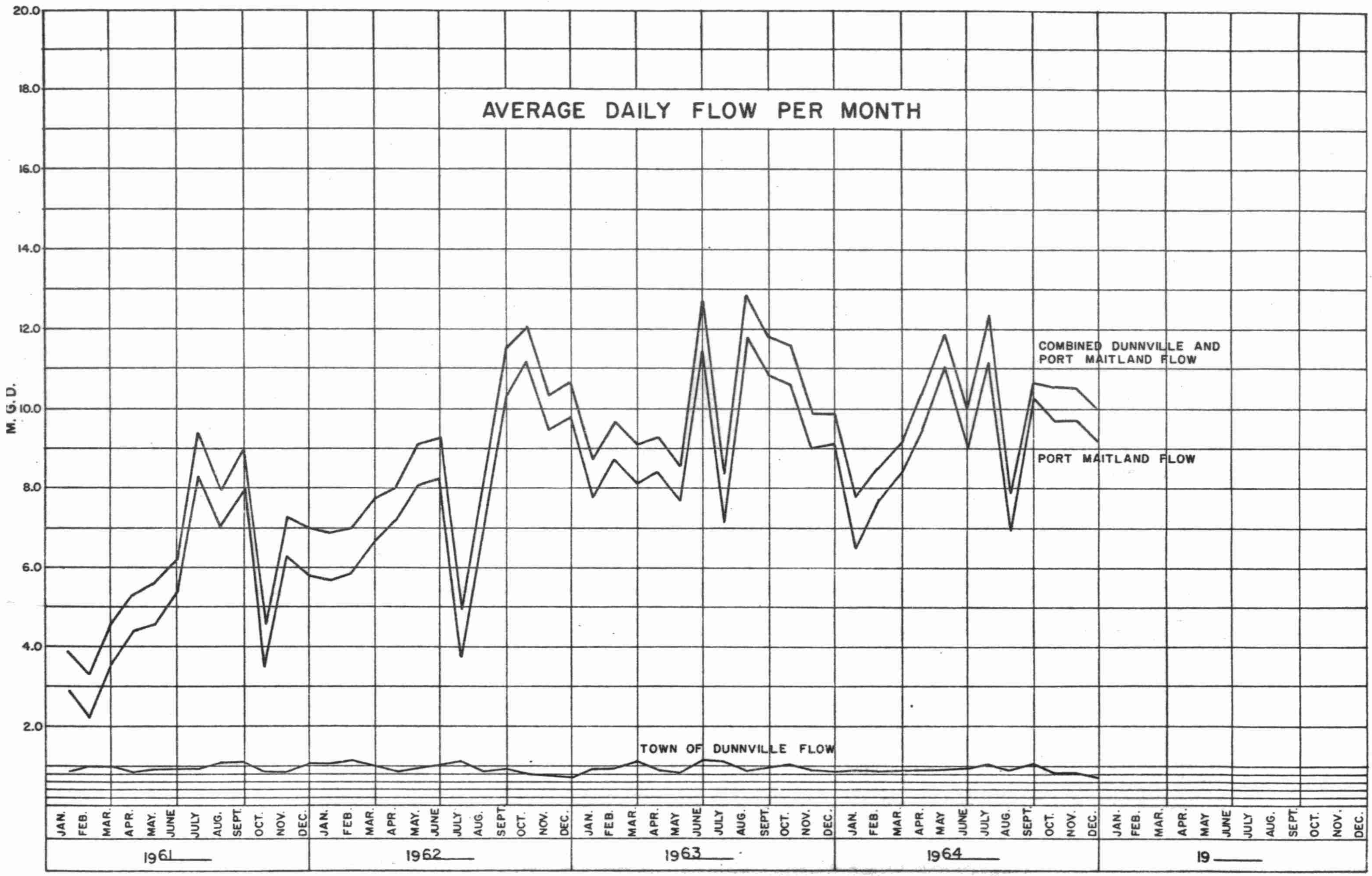
July was the peak consumption month for both the Town of Dunnville and the Port Maitland industries. The average daily plant output for 1964 was 10. 163 million gallons. The maximum daily output of 13. 920 million gallons occurred in July and the minimum daily output of 1. 742 million gallons occurred in August while the industries were partially shutdown.

The following table and three graphs summarize the Dunnville Regional Water System flow data.

*This value is the sum of the readings from the meter on the Dunnville line and the two meters at the Port Maitland industries.

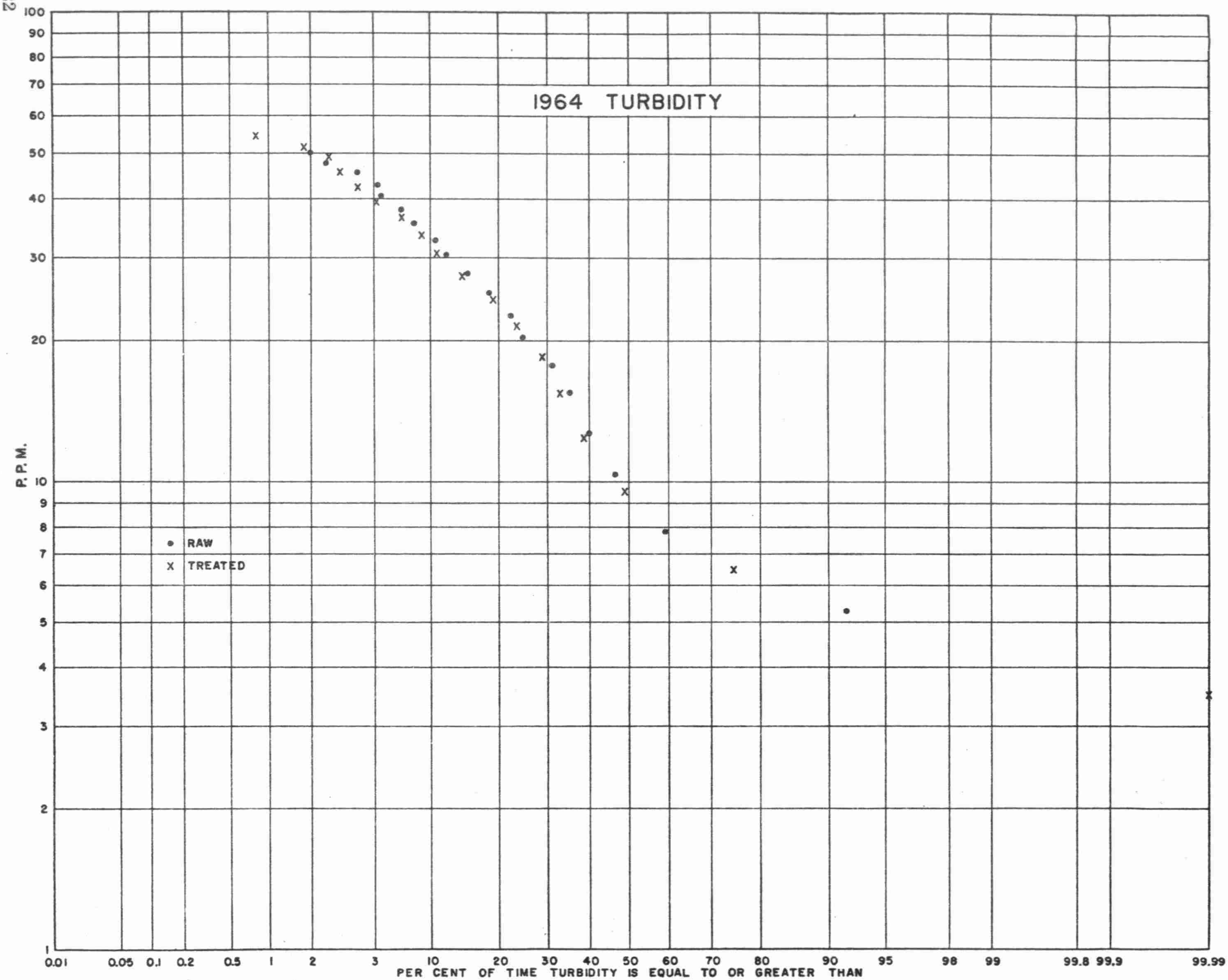

AVERAGE DAILY FLOW
366 SAMPLES
TOTAL PLANT FLOW
PORT MAITLAND
M.G.D.
16
14
12
10
8
6
4
2
0.01 0.05 0.1 0.2 0.5 1 2 5 10 20 30 40 50 60 70 80 90 95 98 99 99.8 99.9 99.99
PER CENT OF TIME FLOW IS EQUAL TO OR GREATER THAN


MAXIMUM FLOW RATE
366 SAMPLES
PORT MAITLAND AND DUNNVILLE
PORT MAITLAND
M.G.D.
20
18
16
14
12
10
8
6
4
0.01
0.05
0.1
0.2
0.5
1
2
5
10
20
30
40
50
60
70
80
90
95
98
99
99.8
99.9
99.99
PER CENT OF TIME FLOW IS EQUAL TO OR GREATER THAN


AVERAGE DAILY FLOW PER MONTH
M. G. D.
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
COMBINED DUNNVILLE AND PORT MAITLAND FLOW
PORT MAITLAND FLOW
TOWN OF DUNNVILLE FLOW
JAN. FEB. MAR. APR. MAY. JUNE JULY AUG. SEPT. OCT. NOV. DEC.
1961
1962
1963
1964
19

MONTHLY FLOWS

Month	Total Flow MG	Dunnville Town MG	Electric Reduction MG	Sherbrooke Metallurgical MG
January	246.245	27.642	95.677	122.926
February	267.224	23.931	91.842	151.451
March	305.413	25.720	99.365	180.328
April	328.606	25.135	96.829	206.642
May	366.211	26.192	101.615	238.404
June	299.936	29.219	103.871	166.846
July	387.747	33.317	119.886	234.544
August	244.541	30.331	98.536	115.674
September	319.380	10.550	117.355	191.475
October	327.632	27.542	114.034	186.056
November	316.649	25.929	96.440	194.280
December	309.984	25.104	96.151	188.729
Total	3719.568	310.612	1231.601	2177.355
% of Total	100	8.35	33.11	58.54
Average Daily	10.163	0.849	3.365	5.949


1964 TURBIDITY
P. P. M.
100
90
80
70
60
50
40
30
20
10
9
8
7
6
5
4
3
2
1
RAW
TREATED
0.01
0.05
0.1
0.2
0.5
1
2
3
10
20
30
40
50
60
70
80
90
95
98
99
99.8
99.9
99.99
PER CENT OF TIME TURBIDITY IS EQUAL TO OR GREATER THAN

TURBIDITY (see graph at left)

The turbidity of water is a measure of the interference presented by suspended matter to the passage of light. This measurement therefore indirectly measures the suspended matter such as clay, silt, finely divided organic matter and microscopic organisms present in the water.

The microstrainers at the Dunnville Regional Treatment Plant are designed to remove only the larger microrganisms particularly algae. It can be seen from the accompanying graph on turbidity measurements that the treatment process does not significantly reduce the turbidity of the raw water. It may be deduced from these results that the major source of turbidity in the raw water is caused by substances smaller than can be removed by the microstrainers.

The U. S. Public Health Standard for drinking water specifies a limit of 10 parts per million. At the Dunnville plant the treated water met this standard only 53% of the time.

BACTERIOLOGICAL ANALYSIS

A total of 201 samples for bacteriological analysis were submitted to the OWRC Laboratory during 1964. Of these samples 51 were of the raw water as taken from the low lift station and 150 were of the treated water as collected from the Sherbrooke Metallurgical plant, the end of the main at the Dunnville P. U. C. and the Grandview School in Dunn Township. Of the 150 samples of treated water, 144 were classed as Grade "A" or satisfactory water, 6 were classed as Grade "B" or water where the pollution present is not sufficient to regard it as unfit for drinking. None of the treated samples were classed as Grade "C" or unsafe for human consumption.

ALGAE ENUMERATION AND IDENTIFICATION (see graph at right)

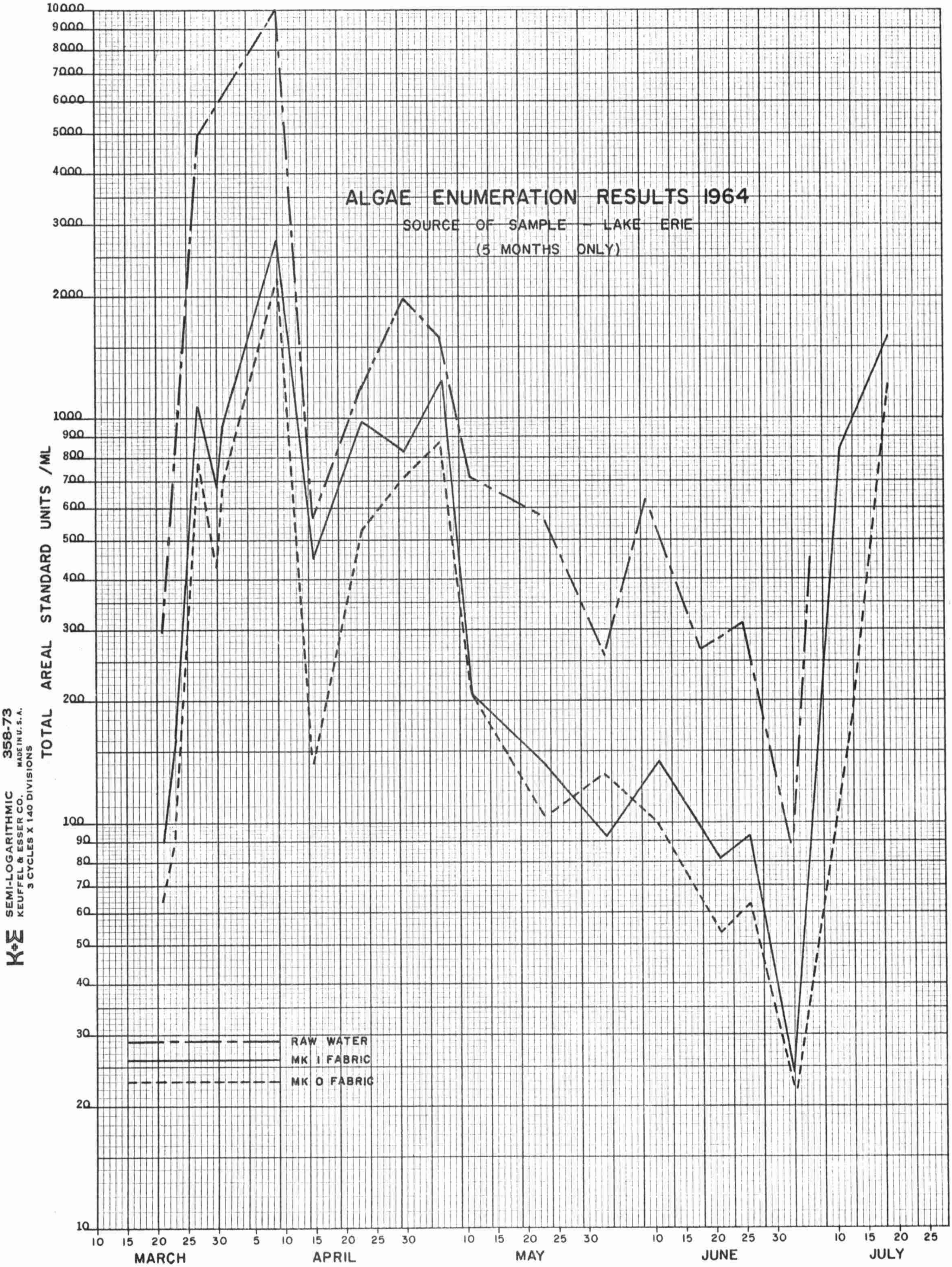
Certain species of algae in drinking water may be responsible for obnoxious tastes and odours. Although there are no pathogenic species of algae, their decomposition products can produce illness in animals which drink the water during periods of heavy algal decay. For these reasons an attempt is made to remove algae from the Lake Erie water by microstraining at the Dunnville Regional Water Treatment Plant.

The accompanying graph shows the effect of microstraining in removing algae from the Lake Erie raw water. It compares the removal achieved by the new Mark 1 fabric, to the original Mark O fabric. Algae enumeration and identification are done periodically on the raw water and microstrained water by the plant staff.

CHEMICAL ANALYSIS

A total of 76 samples were submitted to the OWRC Laboratory for chemical analysis during 1964. Approximately half of these samples were of the raw water and half were of the treated water. There is virtually no change between the treated and raw water due to the dissolved nature of the chemicals and the yearly average values as listed below may be considered as applicable to either raw or treated water. Also included in the table below are normally accepted standards for good quality water.

Description	Hardness As $CaCO_3$ (PPM)	Alkalinity As CaCo3 (PPM)	Iron As Fe (PPM)	Chloride As C1 (PPM)	pH at Lab	Colour in Hazen Un.	Phenols in (ppb)	Sulphates as SO_4 (PPM)
Standards	$<$100	30 to 100	$<$.03	$<$350	6.7 to 8.5	$<$15	$<$2	$<$250
(Yearly Avg.) Dunnville Plant	139	102	0.35	27	8.1	$<$5	3	30



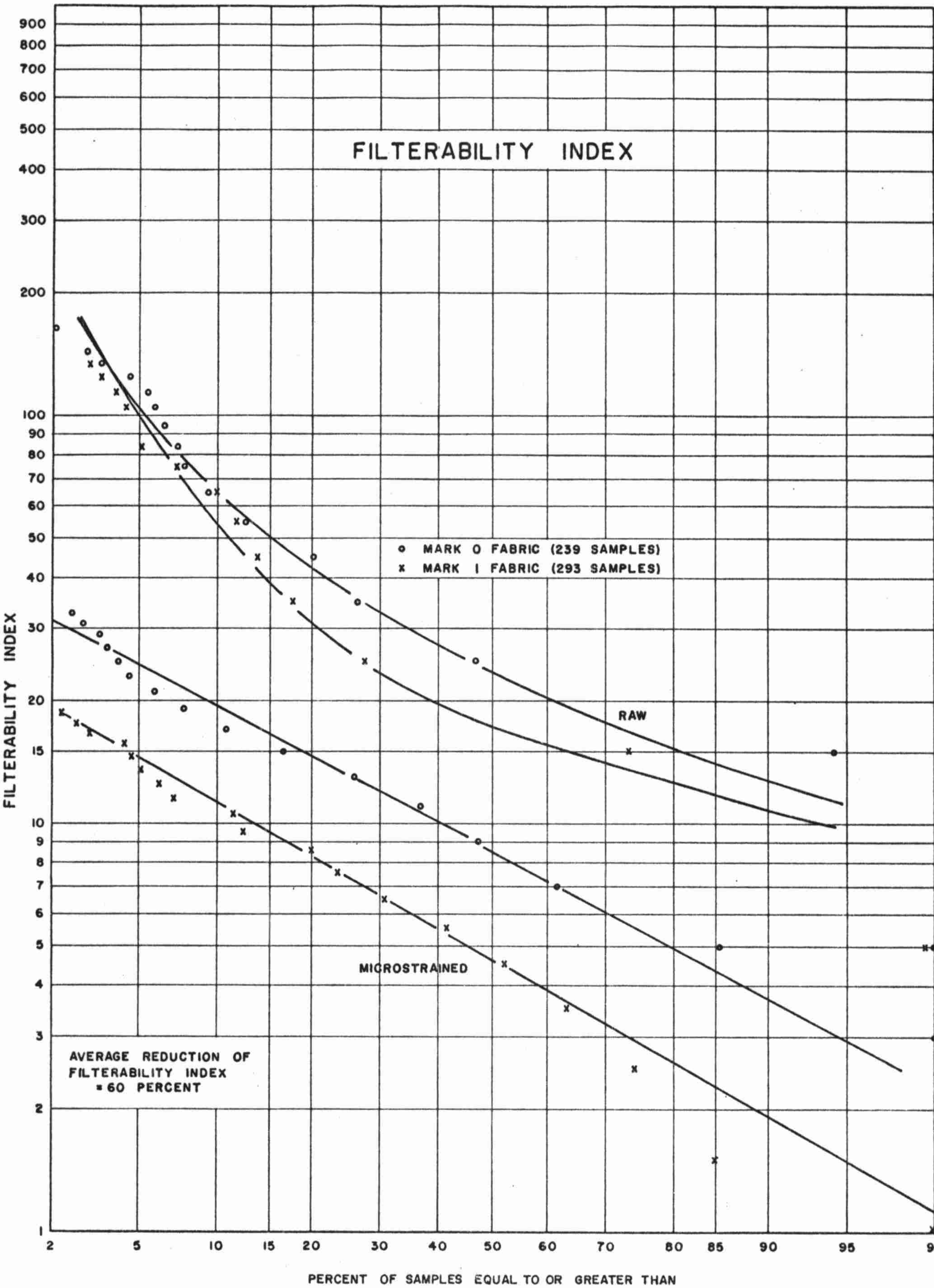
ALGAE ENUMERATION RESULTS 1964
SOURCE OF SAMPLE - LAKE ERIE
(5 MONTHS ONLY)
TOTAL AREAL STANDARD UNITS /ML
RAW WATER
MK I FABRIC
MK O FABRIC
MARCH
APRIL
MAY
JUNE
JULY
SEMI-LOGARITHMIC 358-73
KEUFFEL & ESSER CO. MADE IN U.S.A.
3 CYCLES X 140 DIVISIONS

FILTERABILITY

The filterability index has been developed in connection with microstrainers in order to measure their ability to filter water. The index is affected by the type of microstrainer fabric used and the quality, particularly turbidity, of the water to be filtered.

For a given fabric an increase in the index indicates a poorer quality of water which decreases the capacity of the microstrainers. For a given quality of water the index will increase with an increase in the fineness of the microstrainer fabric.

From the accompanying probability graph of filterability index it can be seen that both the raw and microstrained water are filtered more readily by the new Mark 1 fabric than by the now replaced Mark O fabric. Due to this change of fabric the capacity of the microstrainers has been increased. Longer intervals between cleanings will reduce cleaning chemical costs. The increased microstrainer capacity will be of particular advantage during the summer when in the past their capacity was exceeded by the demand.



FILTERABILITY INDEX
MARK O FABRIC (239 SAMPLES)
MARK I FABRIC (293 SAMPLES)
RAW
MICROSTRAINED
AVERAGE REDUCTION OF FILTERABILITY INDEX = 60 PERCENT
FILTERABILITY INDEX
PERCENT OF SAMPLES EQUAL TO OR GREATER THAN

CHLORINATION

MONTH	DOSAGE PPM	RESIDUAL PPM	CHLORINE USED POUNDS
JANUARY	0.96	0.40	2201
FEBRUARY	0.82	0.40	2057
MARCH	0.84	0.40	2384
APRIL	0.92	0.40	2858
MAY	0.94	0.40	3468
JUNE	0.98	0.40	2934
JULY	1.04	0.40	3852
AUGUST	0.96	0.40	2344
SEPTEMBER	0.91	0.40	2916
OCTOBER	0.82	0.40	2684
NOVEMBER	0.76	0.40	2396
DECEMBER	0.77	0.41	2384
TOTAL			32478
AVERAGE	0.89	0.40	2706

COMMENTS

Chlorination of the water is required to disinfect the pathogenic bacteria. An added benefit of chlorination is the elimination or partial elimination of undesirable tastes and odours. A free chlorine residual of at least 0.4 parts per million after 15 minutes retention is maintained in the treated water by post-chlorination.

PROJECT
PROBLEM

FRAZIL ICE

Problem - Frazil ice accumulating in the intake works of the Dunnville Regional Water Treatment Plant has periodically been a problem since December, 1961. On at least nine occasions the plant has not been able to meet the demand of all the consumers due to partial or total clogging of the intake structure. The longest period of reduced supply occurring in January 1965, lasted for approximately 40 hours. The resultant slowdown in production of the industries due to lack of cooling water from the Dunnville plant is estimated to cost from \$500 to \$1500 per hour.

Formation - Ice is formed when surface water is supercooled due to the loss of heat to the atmosphere by radiation, convection and evaporation. Under calm water conditions a surface sheet of ice will form. However, when the surface of the lake is disturbed by wind and wave action there is an interchange of the super-cooled surface water with water from lower depths. Up to a certain stage the water from the lower depths will prevent ice formation, but eventually the tiny frazil ice particles will begin to form and will be dispersed to different depths depending upon the degree of turbulence. Frazil ice becomes more prevalent as water depth decreases.

Under favourable conditions these ice particles which begin as thin circular discs grow and conglomerate into large spongy masses which readily attach to under-water objects. It is not definitely known where the frazil ice clogs the Dunnville intake, but the probable locations are the intake ports of the timber crib or the 90^{o} elbow below the bellmouth especially if it is partially filled with debris.

Remedial Action - Possible solutions to the Dunnville frazil ice problem include; heated bar racks to replace or cover the intake ports; increasing the size of the present intake ports; an alternate intake port on the existing intake; artificial or controlled ice cover; installation of ice eroding propellor pumps; extending the intake to deeper water; and the emergency use of heat generating chemicals.

A thorough study of the pros and cons of all of these methods as well as any others which may develop must be made before the most reasonable attempt at solving the frazil ice problem is chosen.

CONCLUSIONS

The Dunnville Regional Water Treatment Plant is supplying water to all participants at a reasonable cost. The project is being thoroughly maintained and efficiently operated by the plant staff.

The two outstanding problems which face the project are the periodic clogging of the intake by frazil ice and the increasingly poor quality of raw and treated water. During 1965 the intake is to be inspected to determine if any debris contained in or damage sustained to the intake may be aggravating the frazil ice problem. A preliminary sounding program is also to be performed in order to determine the possible existence of deeper water in the vicinity of the intake crib.

ONTARIO WATER RESOURCES COMMISSION